

Sign Language – are we making information accessible?

Dr. Kirsty J.W. Crombie Smith

Deafax, UK – www.deafax.org

kirsty@deafax.org

1. Introduction

There are currently approximately 40 million people in the world that suffer from some degree or form of deafness, and of these it is estimated that between 1 in 200, to 1 in 2000 use a sign language as their first language. A common misconception is that there is a universal Sign Language. Like spoken languages, signed languages vary from country to country and across regions within those countries. There are numerous signed languages in use around the world, which both deaf and hearing people use as a method of communication. SIL Ethnologue has currently catalogued 130 [18] but this number is growing, as more are found and catalogued. Signed languages use the hands and facial expressions as the primary articulators. Each country's native sign languages have a distinctive grammar and uniquely evolved lexicon, which often depends upon when, where and how the language has evolved. The result is that regional variations are often stronger than those of spoken languages. One reason for this is that Deaf communities are frequently more isolated, and until recently were also less likely to travel. This is in contrast to spoken languages, which have to some extent been standardised by media coverage such as television and radio. Sign languages have had no such standardising influence. However, in the last few years there has been an increase in signed interpreted television programmes in Britain, as well as shows which are both signed and interpreted such as VeeTV and See Hear. This is due, in part, to increased pressure from the EU and Deaf communities, but also to the Broadcasting Act 1996 and the Statutory Order issued on 28 January 1997 relating specifically to sign language [20].

2. British Signed Languages

Within Britain, in addition to British Sign Language, there are a number of formal and informal sign systems directed at certain target groups – not necessarily deaf. These are: British Sign Language, Sign Supported English, Signed English and Makaton.

2.1. Sign Supported English and Signed English

Sign Supported English (SSE) and Signed English (SE) are not independent languages. They are used to accompany a spoken sentence by signing keywords. SSE signs key words; whereas SE signs each

word in the sentence, including the definite articles 'a' and 'the', and adding signs to indicate tense and many other signs needed to fully reflect the intricacies of English grammar.

2.2. Makaton

Makaton was formulated for people with learning disabilities or communication difficulties, by a speech therapist called Margaret Walker. Designed in the 1970s it is used throughout Britain and has been modified for use in over 40 other countries [21]. Makaton is a language programme that uses iconic symbols, speech and signs. It has a basic core lexicon, which is developed by the user as they advance, often adding in signs from their native sign language as and when necessary. It does not follow the sign language grammar structures but that of its native spoken language. For example, in Britain it would not follow BSL rules, but those of English thus making it more like SE or SSE.

2.3. British Sign Language (BSL)

BSL is the official sign language of the Deaf Community within Britain and is used by both deaf and hearing people. BSL was formally recognised as a language by the British Government in March 2003. This means that it is recognised as a national language of the UK, but there still needs to be further legislation before it has the same legal standing as other national languages. The hope is that eventually it will be given equal status with Scots Gaelic and Welsh.

Within British Sign Language there are a number of specific types of signs or attributes which may present problems in recording or simulation. Sign languages are often assumed to be iconic or mimetic, that is a series of gestures or mimes, rather than actual languages. This assumption is based upon the idea that signs somehow represent the object they are referring to, or that sign language is just miming of actions and not a real language. However, work by William Stokoe, Professor of English at Gallaudet University, [14,15] has shown that sign languages have a grammar and linguistic structure similar to that of spoken languages, with the only difference being the modality used to express them. Whilst it is true that some signs do seem to be iconic such as MILK, where the hands simulate the action of milking a cow, it is equally true that there are many signs that seem to have no link to the object or action at all, such as BISCUIT where the dominant hand forms a claw-like shape and moves so that the finger tips cup and contact the bent non-dominant elbow. There are some cases where iconicity is used, in particular the classifiers. However, in general it is often a hearing person learning the language who attaches iconic meanings in order to help the learning and memorisation process.

BSL is an intricate and varied language, which uses both the hands and the face as the primary articulators. The signs are composed of manual and non-manual components. In the BSL dictionary, Brennan suggests that you can classify the BSL lexicon into three types of signs: manual, non-manual and multi-channel [1]. Manual signs are composed of just a manual component, for example the BSL sign BUILD. Non-manual signs are rare but are composed of any other body part excepting the hands, for example the BSL sign THAT'S RIGHT [1]. Multi-channel signs are composed of a combination of manuals and non-manuals, for example the BSL sign HOW MUCH? Within the BSL-English dictionary there are 1739 signs recorded, not including any of the number signs [1].

2.3.1 Manual Component

The manual component of BSL signs is often viewed as a set of different handshapes.

2.3.2 Non-manual Features (NMFs)

NMFs are an important part of sign language and help to communicate the sign's meaning. During signing it is claimed that viewers fixate on the face and track the hands with their peripheral vision [13]. The non-manual features help to clarify the adjectival properties of a sign's meaning, for example changing the sign RAIN from rain to heavy rain. In British Sign Language, the group of non-manual features is composed of a number of different body parts. For example: head movements such as nodding and shaking the head for affirmation or negation of signs; eyebrow movements used in asking questions; eye gaze to indicate placement or role-shift; lip patterns some of which may be borrowed from spoken English but others which are not; body-shifting used in role-shift. The exact amount of NMF, in particular lip patterns, present in signing varies from signer to signer. However, if there are no NMF present in the signing it can be difficult to understand a single sign without a sentence context. Therefore it is important to stress that any synthesis of single signs with just the manual component will not necessarily be understood.

2.3.3. Movement

Signs also contain movement. There are two types of movement that occur in signs, movement that is important to the sign's meaning and transitory movement between one sign and the next. In general, meaningful movement can be divided into categories [1]. Firstly there is movement of direction along one of the 3-dimensional axes. This can be extended with circular movements following curves and ellipses. Then there is the style of movement, whether the hand is bending or twisting or the fingers are wiggling. There is the presence or absence of contact during the movement, the length of the movement whether it is a short or long movement and finally whether

the movement is repeated. Movement that is important to the sign occurs within the signing space – an area in front of the body.

2.3.4. Signing Space

The signing space is an area within which the signs are produced. In general the signs are produced in front of the body with the hands held in a signing space as shown in figure 1. However, within informal conversations this space can enlarge or alter depending upon the signer and for dramatic effect.

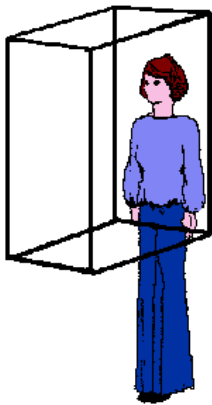


Figure 1. The signing space [24]

2.3.5. Minimal Pairs

The term minimal pair is used for two signs which are identical except for one component. For example the BSL signs LOVELY and UNDERSTAND differ only in the start location [1]. In American Sign Language the signs THANK YOU and BULLSHIT differ only in the final hand configuration [10] – a potential error that could cause embarrassment and offence! Minimal pairs can be useful in examining and defining the important manual components of sign language.

2.3.6. Placement

Placement is used to record a reference point, for a person or object, that will then be referred to at a later stage in the conversation. This allows the signer to describe a person or object once and then give them a position within the signing space, which they are then able to refer back to without re-describing the person/object. Placement can be compared to the use of pronouns within spoken languages [17].

2.3.7. Contact [1, 17]

Contact is also used within signs. This can be divided into initial contact, which occurs at the start of the sign, and movement contact, which occurs during the movement section of the sign. Contact can occur between any part of the hand or body or between both hands. The exact point of contact can be very important such as the sign for HINDU which involves the dominant index fingertip touching the point mid way between the eyebrows, however in some cases the area of contact is important such as the sign MY in which the dominant hand shaped in a fist contacts the chest. These two different styles of contact, specific and general, both need to be recordable by the notation. The different timings of contact also need to be specified, i.e. whether the contact is at the start of the sign or during the movement.

3. Writing Sign Languages

Signed languages use the hands and facial expressions as the primary articulators. The linguistic structures of native Sign Languages are nearly always different from the native spoken languages of the countries where they are used. For example in Britain, where 1 in 6 people have a hearing loss and BSL is the first language of 125,000 deaf adults [7], the difference between structure of British English and BSL can be shown through the question ‘what is your name?’ as it becomes ‘name what?’ in BSL. There is at present no fully accepted writing system for most sign languages. Although some notation systems claim that they can be used for this [15,12], there is no evidence of large-scale use by any Deaf communities. This means that at an early age deaf children attending school could be learning two languages (depending on the school) – one to communicate with face-to-face and one to read and write with. The results of this have been highlighted by a recent study carried out on the request of the European Union of the Deaf. It reported that within Europe, profoundly deaf 16 year olds have an average reading age of less than nine years [9]. There are many possible reasons for this. Historically the 1880 Second International Congress on Education of the Deaf held in Milan decided that oral teaching was superior to signed teaching. This resulted in a ban on signed teaching in most British and other European schools [22]. The consequences of this were poorly educated children who were not proficient in any language. The repercussions of this edict are still evident today, and it is only during the last few decades that things have begun to change. There are now a number of bilingual (BSL and English) schools within Britain today and several others which allow mixed modes of communication where signing and speaking are used at the same time – typically this is termed a ‘total communication’ approach.

Most deaf children are born into hearing families and their use of sign language may be limited until they are of school age. The first years of school are spent learning to communicate effectively as well as learning all the other basics. Conversations with Teachers of the Deaf have supported the view

that there can still be a delay in the detection of deafness in children. However, this should in future no longer apply as there is universal screening of all new-borns and all early hearing loss should be discovered. Those with no fluent first language can suffer from behavioural difficulties due to communication frustration. Although there are a number of reasons for this, this resultant low literacy level means that the reading of books, Bibles, subtitles and other general information is often too difficult for many pre-lingually deaf people, and these communication modalities are more suitable for those who have gone deaf in later life. Therefore, a means of displaying information that is more accessible for Deaf people needs to be found. This is increasingly important in the field of translation where Deaf communities are increasingly requesting materials in their own language.

4. Translating sign languages

William Stokoe was the leading pioneer of Sign Language research. Whilst Professor of English at Gallaudet College, (now Gallaudet University for the education of the deaf and hard of hearing), he publishing his Stokoe Notation. This was designed to record American Sign Language (ASL) and first appeared in '*A Dictionary of American Sign Language on Linguistic Principles*' in 1960. This enabled American deaf people to look up signs for the first time using handshapes, rather than having to know the English equivalent. Since then other notational systems have been developed and used to record different Sign Languages round the world – most notably HamNoSys (an academic system developed in Hamburg [19]) and SignWriting (adapted from a system to record dance moves [16]). All the notational systems were used to describe Sign Languages, and whilst useful for replicating signs they were not easy for lay people to use. Although computer scientists have been studying methods of speech generation as well as speech recognition systems since the early 1970s, it is only recently that there has been an increased interest in Sign Language and computing. The recent development of virtual reality signing represents the shift of interest to this new area. The results of this work could offer benefits both to the Deaf and Hearing Communities. Sign Language translations are complex. Two approaches tend to be used: firstly the filming of live signers, and secondly through generating computer animations of signs. Whilst recording signers signing and using it to create films can be expensive and time consuming to produce, the end results provide the user with a real-life person. The problem with this is that culturally in some countries, the use of a person is unacceptable and the personal beliefs and behaviour of the person signing become confused with the information being given. In these situations the use of a virtual signer would avoid any personality tainting, enable dynamic signing and therefore could be used to accompany any digital media. The following four notations have been used to generate computer simulated signing.

4.1. Stokoe Avatar

Named after its creator, the originator of sign language research as a credible linguistic endeavour, the Stokoe Notation was created following similar lines to those used to create spoken language notations. Stokoe discovered that there were a number of hand shapes that recurred in American Sign Language and decided that one of the parameters was handshape, which he called designator or 'dez'. He then followed a well-trodden linguistic path and looked for minimal pairs in order to determine other specific features. He defined a further two; place of articulation called tabulation or 'tab' and action called signation or 'sig' [14,15]. There are 55 iconic symbols from which the sign can be composed: 12 specified for tabulation only, 19 specified for the designator but which can also be used for tabulation, (these are similar to the signs in the ASL fingerspelling alphabet), and the remaining 24 iconic symbols are used for signation. The Stokoe Notation is currently under-review for inclusion in Unicode. Stokoe notation is used in a number of sign language dictionaries around the world including American Sign Language, British Sign Language, Italian Sign Language and Hong Kong Sign Language.

The Stokoe notation was used as a base for American Sign Language (ASL) SignSynth, an Internet-based prototype sign synthesis application [6]. It uses Mandel's adaptation of the Stokoe notation, converting it into ASCII characters with a linear format [6]. He then defines four 'phonological subsystems' – lexical signs, classifier signs, fingerspelling and non-manuals. Lexical signs are signs such as WOMAN or DRINK. Classifiers are a group of signs that are used as an abstract representative of the object or action. For example the handling classifiers are used to represent the object being handled. Fingerspelling is the manual representation of the English alphabet. Non-manuals are all the parts of the sign not using the hands, such as facial expression or body shift.

There are two advantages of the Stokoe avatar. Firstly the system is open-source and so free. Secondly, the humanoid is created in VRML (Virtual Reality Modelling Language) so is simple. However although this makes it fast to render, the resultant figure is blocky and unrealistic. The movements generated are limited due to the underlying notation. The creator himself concludes the notation was not a suitable base as it does not record all the important necessary parts of the sign [6].

4.2. Sign Writing Avatar

Valerie Sutton created SignWriting in 1974. It uses iconic symbols to represent the handshapes, movements, facial expressions and body shifting of signed languages [16]. Its aim is to be an international 'alphabet' for signed languages. Since its invention, SignWriting has been developed by its native deaf users into a more intuitive system. A computer program has been created to write the

signs using SignWriting [12,16]. SignWriting is designed to be a graphical representation of the sign. It can be written in a full body form using a stick person; a 'stacked' form which removes the stick figure, placing the iconic symbols above and below each other; or in a hand-written or short hand form. It can express the sign from the signer's or the viewer's viewpoint. Generally signs are written from the signer's perspective. This means a sign is recorded as though the viewer was looking through the signer's body at the hands. It is written in columns, the signs being recorded top to bottom rather than left to right. The column can then be used to position the different parts of the body to the centre, left side or right side. The system only records what is present; if there is no facial expression then none is recorded [16].

SignWriting has been implemented and used to drive an animated signer in the V-sign project [11] and is currently being used in the Spanish Sign Language Bible translation project.

In the V-sign project the notation was used to create Sign Writing Markup Language (SWML), an XML-based language, then the SWML file was used to drive a VRML avatar linking the static parts of the sign using quaternion equations. The system has been fairly successful but has experienced a number of problems. The initial use of quaternion interpolation was complex and so linear interpolation was used instead which was seen to be very effective and much simpler. There have been issues with contact and complex movements which were estimated in the key framing and were not accurate enough in the output [11]. The result was a VRML avatar that signs fixed ASL phrases [11]. The Spanish Sign Language Bible translation project is using it to record the signs and then it is being manually encoded to produce a virtual person who is signing.

The SignWriting system is a good start at sign synthesis, and much can be learned from this system. It handles many of the key concepts within sign languages. There is a problem with the lack of placement - the position in the signing space of objects or people during a conversation, these can then be referred back to as required, and The signs are fixed which means co-articulation is not handled well, so sentences can appear jerky. It is also difficult to determine how the SignWriting has been encoded within the computer, the SignWriting notation is a visual system of icons and images, computers need numerical inputs and there is no evidence of where these inputs come from.

4.3. HamNoSys Avatar

HamNoSys was developed about 20 years ago after research by a group of deaf and hearing people at the University of Hamburg, Germany [23]. It was designed as a linguistics research tool, which could be used to transcribe any sign language in the world. HamNoSys is composed of a number of iconic symbols representing the different aspects of the sign. These iconic symbols are then placed in a strict order. At present there are a number of projects using HamNoSys. He ViSiCAST is one project

which attempts to use HamNoSys as a basis for a synthetic animation of sign language [8]. The first projects involved using 'Simon-the-Signer' for television (SignAnim) and 'TESSA' [3] to aid transactions in Post Offices around Britain. These projects looked solely at generating signing from motion capture, linking speech or text directly to signs. The results of these projects were mixed and concluded that the animations were good but that the background input was poor. More was needed to control and drive the animations. The limited phrases were also irksome to both the speaker and the signer. A system that could generate all signs more easily was needed. Another problem with the animation was the delays in production of the signing, i.e. between the clerk speaking and TESSA signing causing irritation to both parties. The system therefore needs to work at real time. Both projects also produced Signed Supported English (SSE) not BSL which deaf people did not like [2,3]. The follow-on project ViSiCast took these two systems and further developed them with HamNoSys into a more general sign language animation package. This has now developed even further with Visia2 and Visia3, but is still not widely used by the deaf community.

4.4. Nicene Avatar

The Nicene Avatar is the only avatar based on a notation specifically designed for computer synthesis. It follows a three layer approach, 'thought', 'word' and 'deed'. This means the system takes text input into the 'thought' layer changes it to experimentally based numerical inputs in the 'word' layer, and finally uses mathematical formulae in the 'deed' layer to generate a real-time signer [5]. The resultant avatar at present only signs the manual component of BSL, but work on non-manual features is on-going. Feedback [4] about the avatar – Ivy Tar, has been collected via an online demonstration and questionnaire, and by a focus group of people trying to use the system themselves. The initial feedback from the website was that they like Ivy. They could understand most of the signs and they could perceive a use for her in the future. The focus group feedback has also been positive; they found the inputting of the information user-friendly and they liked the resultant signs. There were problems with the signs not look exactly how they thought they would, but this was due to incorrect input. More work on making the initial input easier and clear needs to be done. Overall, the signing is smooth and the manual parts of the signs are understandable. The issues of co-articulation also seem to be handled intuitively by the Nicene notational system and a trial signed sentence demonstrated this. The Nicene Notation has been used by the Wycliffe Bible Translators in America as a base to look at automatically generating animations of signs.

5. The next step

The implementation of a notation into a computer program to generate virtual signing is not a trivial problem. Whilst the existing notations and their corresponding avatars have provided a way forward, we need to ensure that the process followed produces an input suitable for computers. In addition, the avatars need to be tested and evaluated by users on the recognisability of the signs and the overall appearance or usability of the avatar.

There are numerous sign language translation projects happening around the world, many of them by Bible Societies including America, Thailand, Japan, Costa Rica, and Australia. With organisations beginning to be aware of the importance of Sign Language translations, it is key that they learn from others and avoid the pitfalls. It is also important that they are given the tools to help produce a suitable result. At present most of the translation projects are filming real-life signers but as new software and support becomes available, it could become faster and cheaper to create virtual signers. But the challenge is: are we too focused on spoken languages and adding Sign Language as an afterthought? Or are we meeting the challenges head on and embracing them.

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